HYCOM Coastal Ocean Hindcasts and Predictions: Impact of Nesting in HYCOM GODAE Assimilative Hindcasts

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LONG-TERM GOALS

The overarching goal is to improve our capability to model and understand currents and water properties in the coastal ocean, and to improve our capability to forecast future changes in these currents and water properties. Coastal ocean models are used for a wide range of purposes, including naval operations, commercial marine operations (including the influence of ocean currents on shipping and oil rigs), storm surge prediction, prediction of pollution dispersion, studies of coastal fisheries and ecosystems, and providing ocean currents for search and rescue operations. This project focuses on one important aspect of improving the performance of coastal ocean models, specifically improving the quality of the fields that are used to initialize these models and provide information on water properties and currents outside of the coastal region being modeled. Although the coastal ocean is strongly influenced by surface atmospheric forcing and coastal freshwater runoff, offshore ocean variability exerts a very significant influence in many regions due to a wide range of processes such as basin-scale climate variability, boundary current meanders, and offshore ocean eddies. To accurately represent the influence of this offshore variability on a coastal ocean model, the model must be nested within fields that accurately represent (1) the initial state of the coastal ocean throughout the model domain and (2) currents and water properties at the nested model boundaries. We will specifically evaluate the use of the HYbrid Coordinate Ocean Model (HYCOM) data assimilation product developed as part of the Global Ocean Data Assimilation Experiment (GODAE) for this purpose. The influence of these initial and boundary fields on the performance of the coastal model will be thoroughly evaluated. This information will provide important feedback that will be used to guide improvements to the HYCOM-GODAE product that provides the initial and boundary fields. The overall regional focus will encompass the coastal Gulf of Mexico through the Florida Straits, which represent a broad range of shelf geometries, river runoff, seasonal atmospheric forcing differences, and both weak and strong offshore forcing to enable the impact of the HYCOM GODAE product to be studied over a wide range of conditions.

OBJECTIVES

Specific objectives include (1) determining the impact of the HYCOM GODAE product on the capability of nested models to hindcast and predict the coastal ocean environment; (2) evaluating the coastal hindcasts and predictions with observations that include existing elements of the Coastal Ocean Observing System; (3) identifying the most useful observations for evaluating and improving coastal ocean models that should be maintained as part of a coastal observation network; and (4) providing feedback for improving the HYCOM GODAE product and other products that provide initial and boundary information to nested coastal models. The overall regional focus will encompass the coastal Gulf of Mexico and the Florida Straits with emphasis on three regions: the South Florida Coastal Region (SFCR), including the Florida Straits, the Florida Keys and Atlantic Keys shelf, Florida Bay, and the adjacent southwest Florida shelf; the entire West Florida Shelf (WFS); and the Northern Gulf Coastal Region (NGCR). The SFCR study is part of the environmental monitoring effort being conducted as part of the Everglades restoration effort. The NGCR modeling effort will include the time interval impacted by Hurricane Katrina.

APPROACH AND WORK PLAN

Each of the three coastal modeling efforts will conduct nested ocean hindcasts, and then use all available in-situ observations to evaluate coastal model performance. Sensitivity to initial and boundary conditions will be assessed as follows: Coastal hindcasts will be run (1) with HYCOM-GODAE initial and time-varying boundary conditions; (2) with HYCOM-GODAE initial conditions and boundary conditions that are held constant in time; and (3) with climatological initial and boundary conditions. For evaluation, these runs will be compared to each other, to the hindcast fields that provided initial and boundary conditions, and to in-situ observations. Evaluation will be performed not only on coastal hindcasts, but also on model predictions. Two sets of forecast runs will be performed, one where the boundary conditions are held constant and one where they are provided by HYCOM GODAE assimilation system forecasts. Forecasts will also be initialized from coastal model runs where observations are assimilated to improve the accuracy of the initial fields. We can then assess to what extent this assimilation improves coastal model predictions, and identify those observations that lead to the most improvement and thus have priority in being maintained as part of the Coastal Ocean Observing System.

WORK COMPLETED

This project was funded at the end of the prior fiscal year, so no work has been completed. As of this writing, work is underway to produce the first run of the HYCOM-GODAE product to be used in this project. It will be completed and provided to the groups running the nested coastal models during January 2006.

RESULTS

No results have been obtained to date.

IMPACT/APPLICATIONS

National Security

This project will improve the capability of HYCOM to hindcast and forecast currents and water properties in the coastal ocean. HYCOM will be transitioned to the U. S. Navy for operational use by FY2008, and will be used to provide information on ocean currents and water properties for naval operations.

Quality of Life

Improved performance of coastal ocean models will improve our capabilities in commercial marine operations (including the influence of ocean currents on shipping and oil rigs), storm surge prediction, prediction of pollution dispersion, studies of coastal fisheries and ecosystems, and providing ocean currents for search and rescue operations.

Science Education and Communication

As part of this project and the HYCOM-GODAE project, we are making research results available on the internet – see http://hycom.rsmas.miami.edu. These projects are supporting graduate students.

TRANSITIONS

National Security

The ocean model used in this study (HYCOM) will become the operational ocean model used by the U. S. Navy by FY2008. The work performed under this project will lead to model improvements that will positively impact Navy operations.

RELATED PROJECTS

The HYCOM-GODAE product is being developed as part of a NOPP project funded by ONR and NOAA to develop a global ocean data assimilation system that will be used to both nowcast and forecast the state of the global ocean. This project will provide information that will be used to improve the HYCOM-GODAE product.